

EXHIBIT I

Photography 101

Fredo Durand
MIT CSAIL



What do I know about good pictures?

- Not much: amateur photographer, wildlife, travel, portrait



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I like equipment

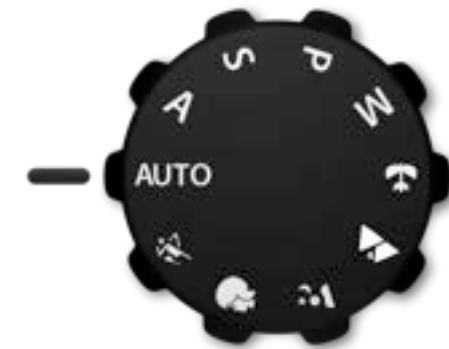
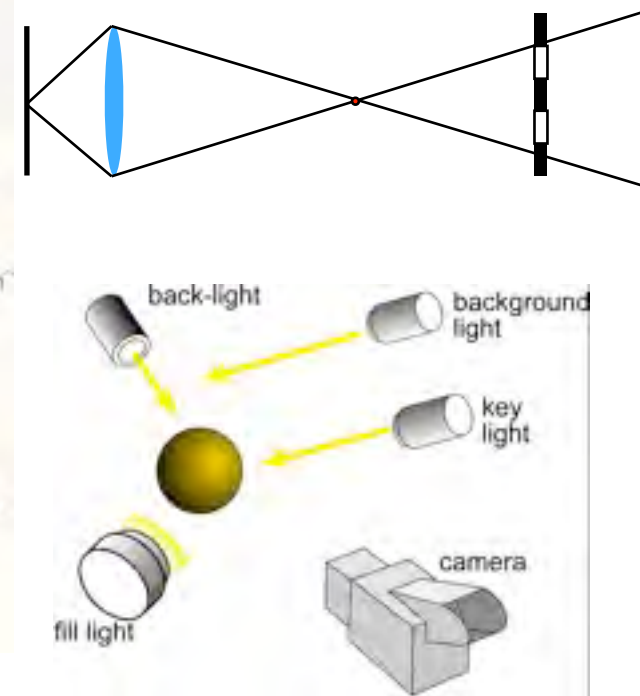
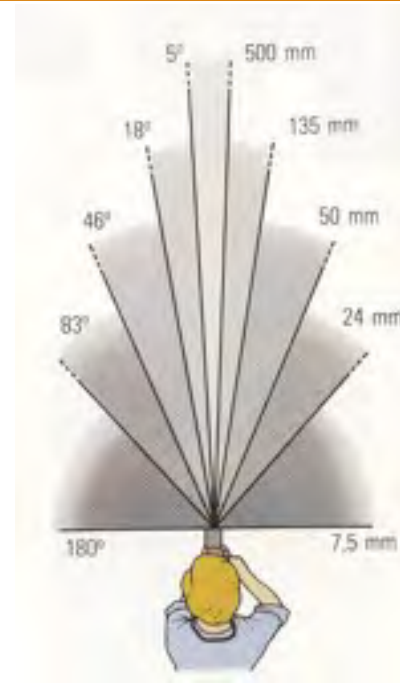
- I am a geek!



- Also I teach
 - 6.815 Digital and Computational Photography**
 - 6.865 Advanced Computational Photography**

Plan

- **Imaging parameters**
 - Camera
 - Lighting
 - Software
- **Equipment**
- **Improving your pictures**



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- **<http://people.csail.mit.edu/fredo/>**
- **More material at**
 - **<http://stellar.mit.edu/S/course/6/sp11/6.815/>**
 - **<http://graphics.stanford.edu/courses/#cs178>**

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Short bio

Frédéric Durand is an assistant professor in Electrical Engineering and Computer Science at the Massachusetts Institute of Technology, and a member of the Computer Science and Artificial Intelligence Laboratory (CSAIL). He received his PhD from Grenoble University, France, in 1999, supervised by Claude Zach and George Dinterakis. From 1999 till 2002, he was a postdoc in the MIT Computer Graphics Group with Julie Hanrahan.

He works both on [graphics](#), [image generation](#) and [computational photography](#), where new algorithms extend powerful image enhancement and the design of imaging system that can reveal richer information about a scene. His research interests span most aspects of picture generation and creation, with emphasis on mathematical analysis, signal processing, and inspiration from perceptual sciences. He coauthored the first [Symposium on Computational Photography](#) and [Vista](#) in 2005, the first [International Conference on Computational Photography](#) in 2009, and was on the advisory board of the [Image and Vision '07](#) conference. He received an inaugural [Computing, Imaging Research Award](#) in 2004, an [NSF CAREER award](#) in 2005, an inaugural [Microsoft Research New Faculty Fellowship](#) in 2007, a [Sloan fellowship](#) in 2006, and a Spence award for distinguished teaching in 2007.

Students and collaborators

If you want to work with me, EAD for prospective students and post-docs:

[Yaelinda Koyukerzky](#), [Javier "Kevla" Chen](#), [Eugene Chik](#), [John Davis](#), [Tillus Jind](#), [Haoxi Li](#), [Benjamin Jonathan Rogers-Kelley](#), [Alex Evans](#), [Si-Chang Shih](#), Emily Shteing

Past or current students and external collaborations: [Amit Levi](#), [Shagun Mishra](#), [Tom Arslan](#), [Thomas Bay](#), [Amir Eliaz](#), [Klausen Thomas Deussen](#), [Yaron Shechtman](#), [Adrian Cristobal](#), [Max Chen](#), [Min-Chi Yen](#), [Seung-Hye Cho](#), [Burt Cori](#), [Soheil Shafiei](#), [Matthew Trachsel](#), [Jun Kim](#), [Ajay Nigam](#), [Tom Mangan](#), [Sydney Fries](#), [Will Humphreys](#), [Miles Duggart](#), [Andrew Blomstone](#), [Taey Sung Cho](#), [Nikhil Bhattar](#), [Kevin Ryan](#), [David Ben-Artzi](#), [Karim Abu-Jaber](#), [Paul Green](#), [Sara Su](#), [Srinivas Puri](#), [Masaru Ichii](#), [Adam Lischinski](#)

[Researches for students](#) (potential resources about writing, career, being a successful graduate student). In particular see my draft of [notes on writing](#), [notes on giving a talk](#), slides about [creating art & ethics](#), and slides about [jobs](#). For my students: [Policy](#), [lectures notes](#), etc.

Photos:

Sample Photos	Everybody	Tactaria	Everybody	Halalopolis	Boatlog
Alaska	Survivalists	Monalisa & Duke Lastra Nobles and advice	China Collection of links to travel guides for photographers	Playing with light	Rockport
		Goldenrod		Downtown, NJ	New Orleans
		Tactaria Alaska @Columbia		New York from an Air World's summit	
Japan	Artemis				

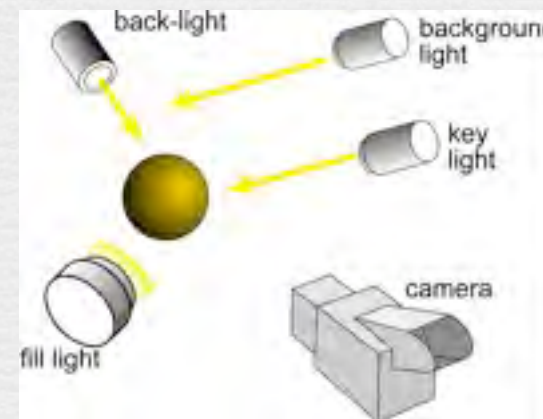
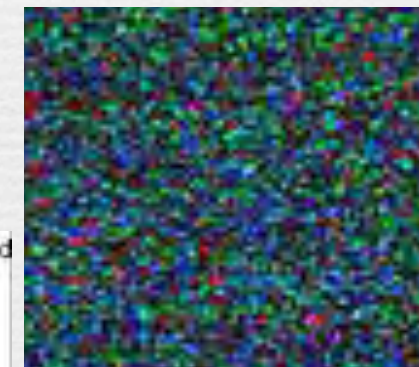
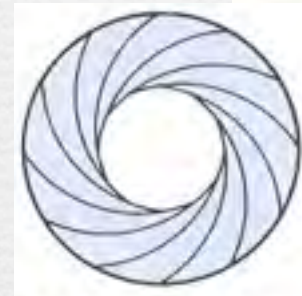
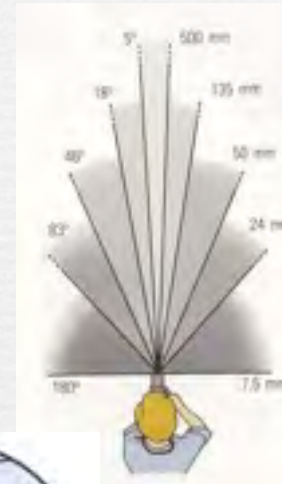
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Imaging parameters

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Imaging parameters

- ◆ Focal length
 - Sensor format
- ◆ Shutter speed
- ◆ Aperture
- ◆ ISO
 - Noise, sensor size
- ◆ Lighting
- ◆ Software



Focal length = field of view

- zooming changes the focal length 24mm

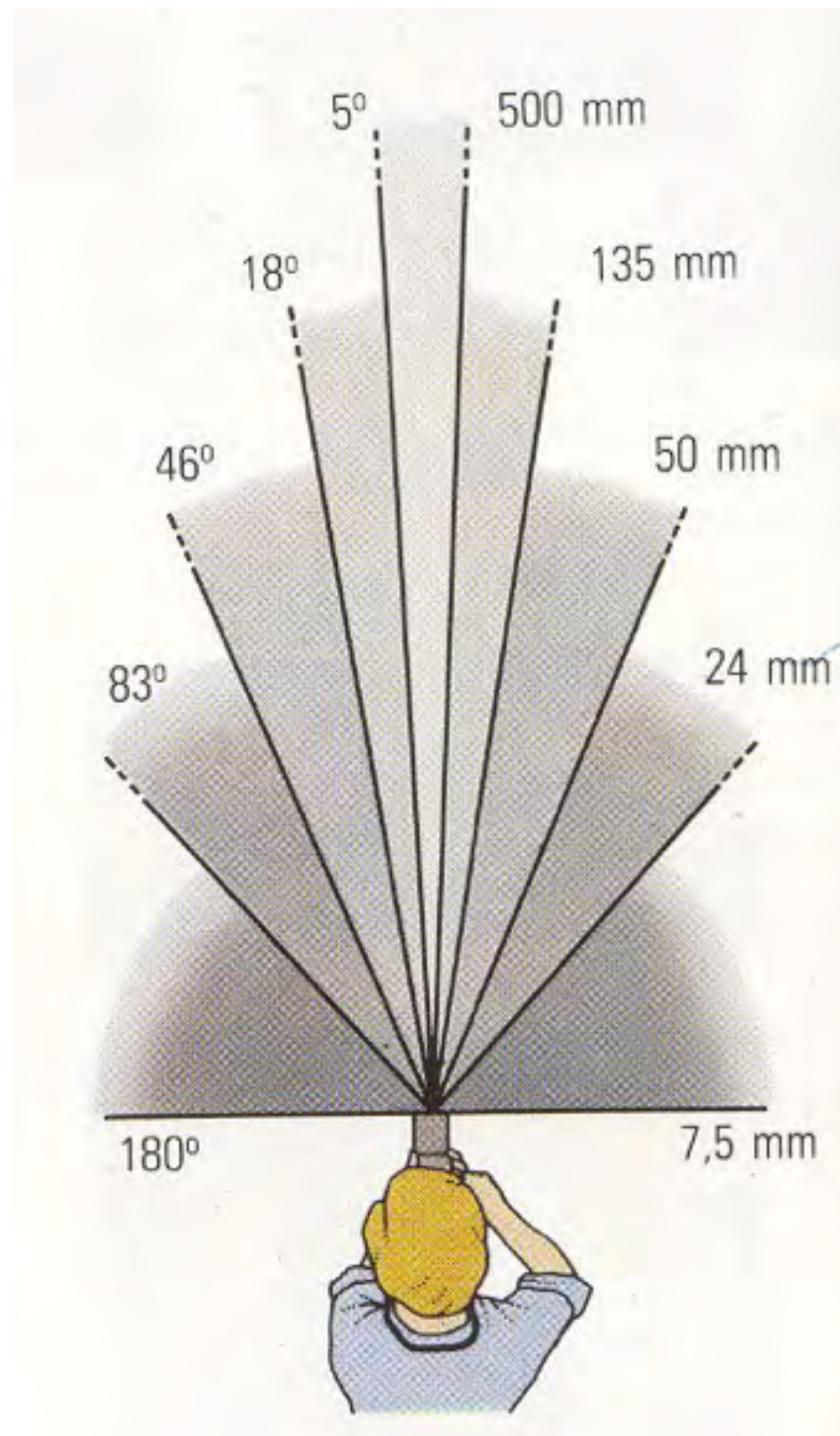


50mm

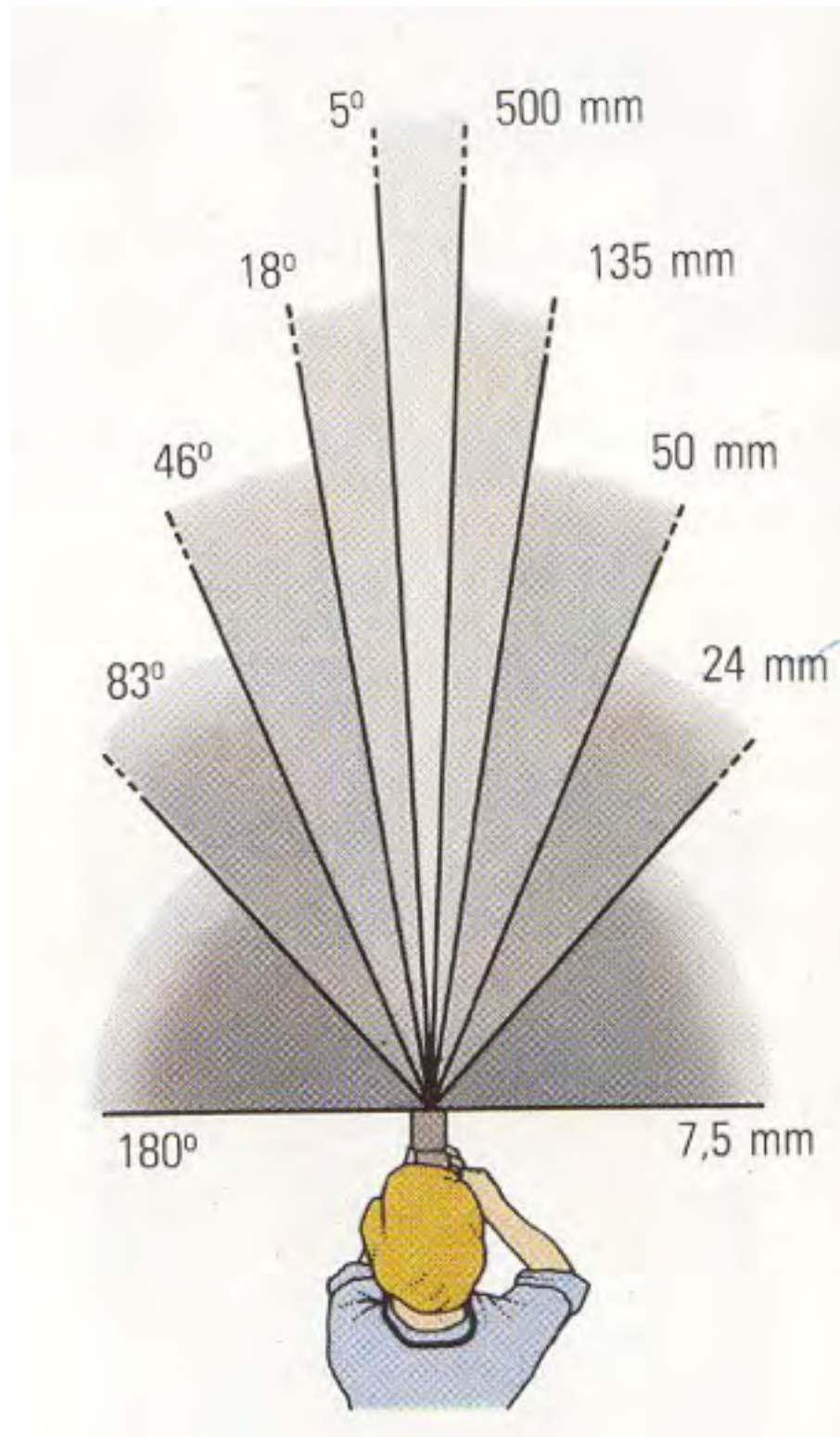


135mm

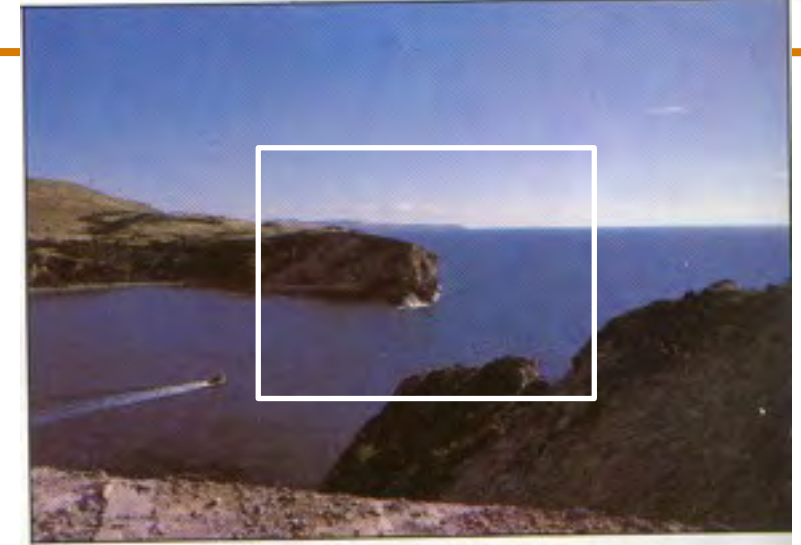
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Focal length = cropping



24mm



50mm



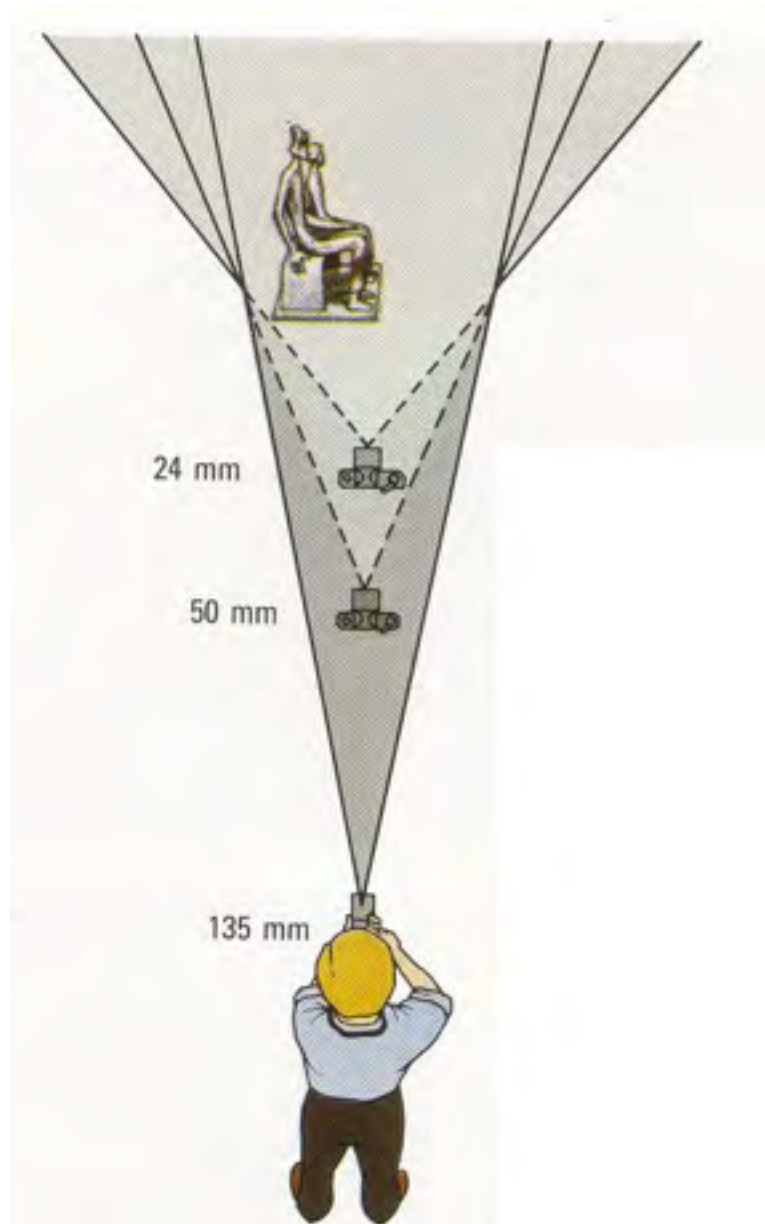
135mm



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Focal length vs. viewpoint

- Telephoto makes it easier to select background (a small change in viewpoint is a big change in background).



Grand-angle 24 mm



Normal 50 mm



Longue focale 135 mm

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Perspective vs. viewpoint

- **Portrait: distortion with wide angle**
- **Why?**



Wide angle



Standard



Telephoto

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Very wide angle: include but distort

- Difficult lens to use because it includes so much
- enables wide range of scales



24mm



18mm



16mm

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Normal: neutral



50mm



55mm



50mm

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Medium telephoto: isolate



95mm



110mm



110mm



150mm

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Super telephoto



910mm



910mm



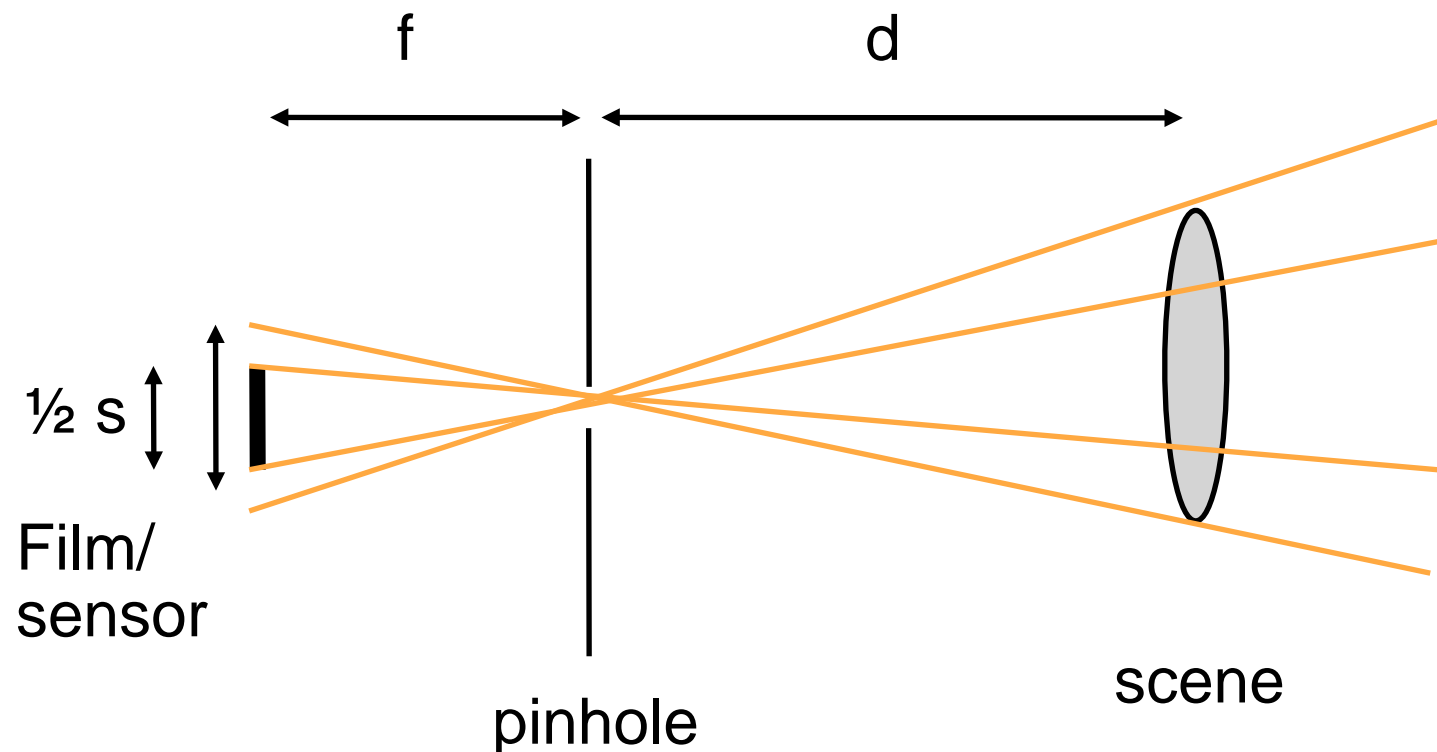
390mm

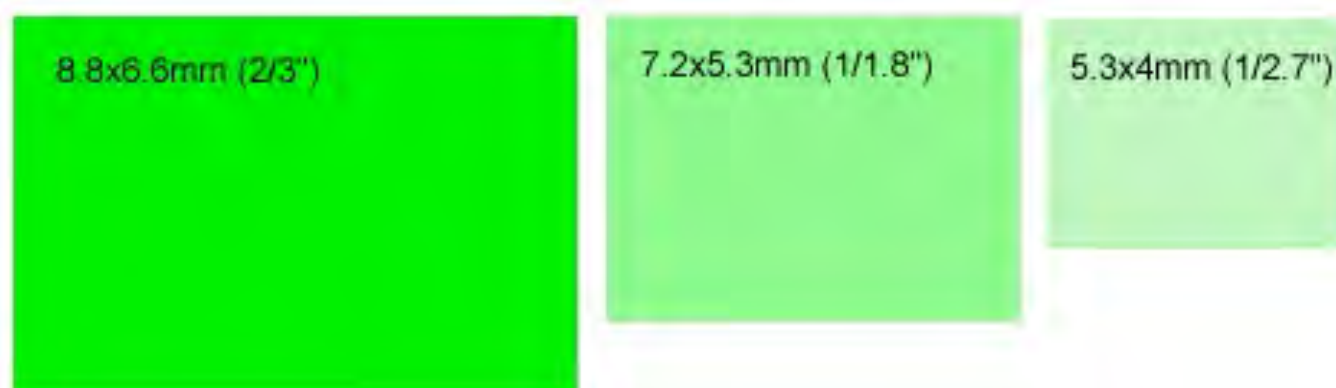


910mm

Focal length & sensor

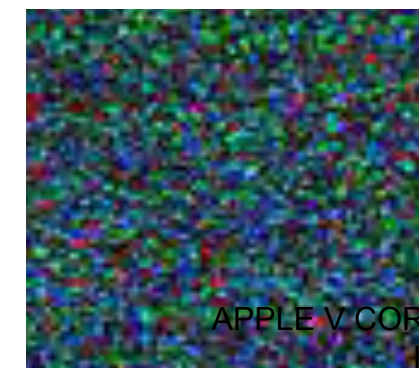
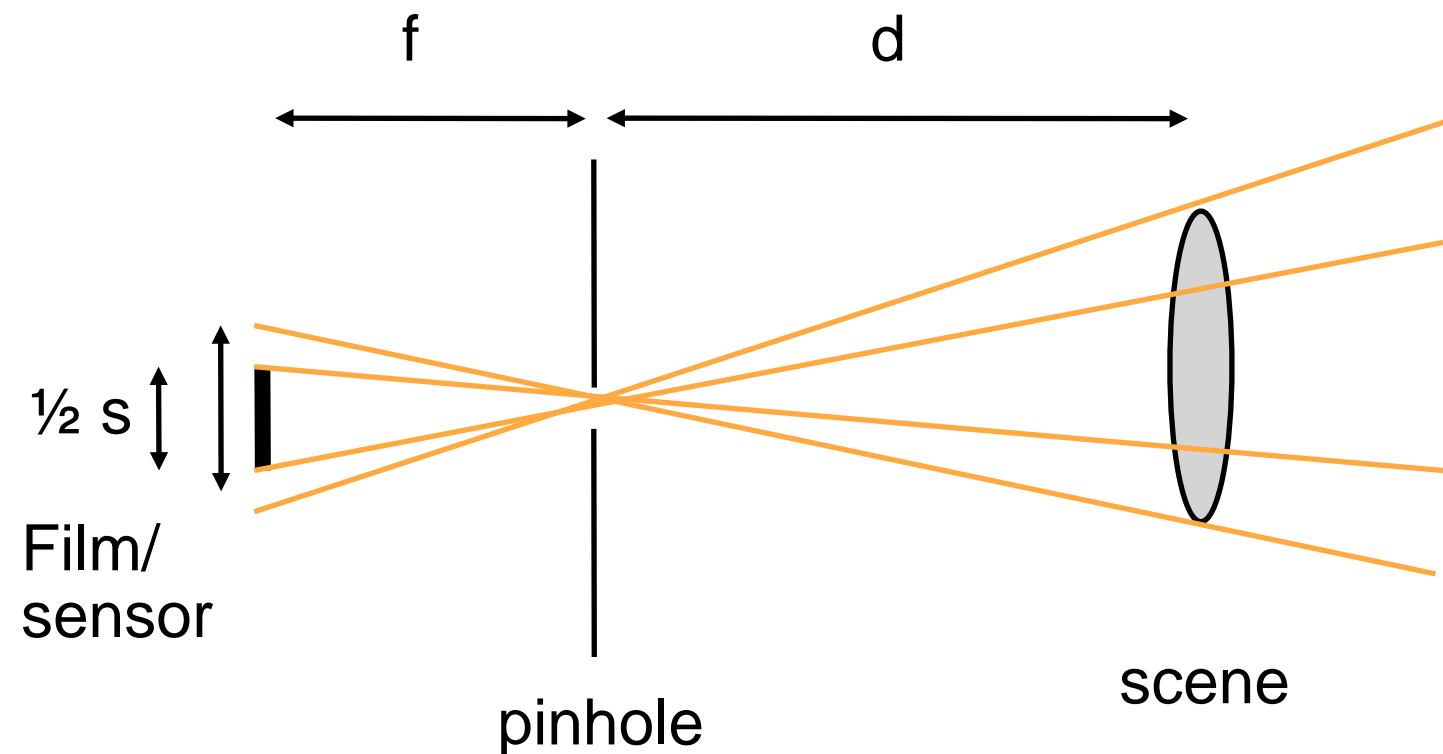
- **What happens when the sensor is half the size?**
 - It's like cropping!
 - The field of view is reduced by a factor of 2
 - The equivalent focal length for is multiplied by 2
 - Hence the so-called crop factor, and the notion of 35mm equivalent focal length
- **Most affordable SLRs have a 1.5 crop factor**





Consequences of smaller sensor

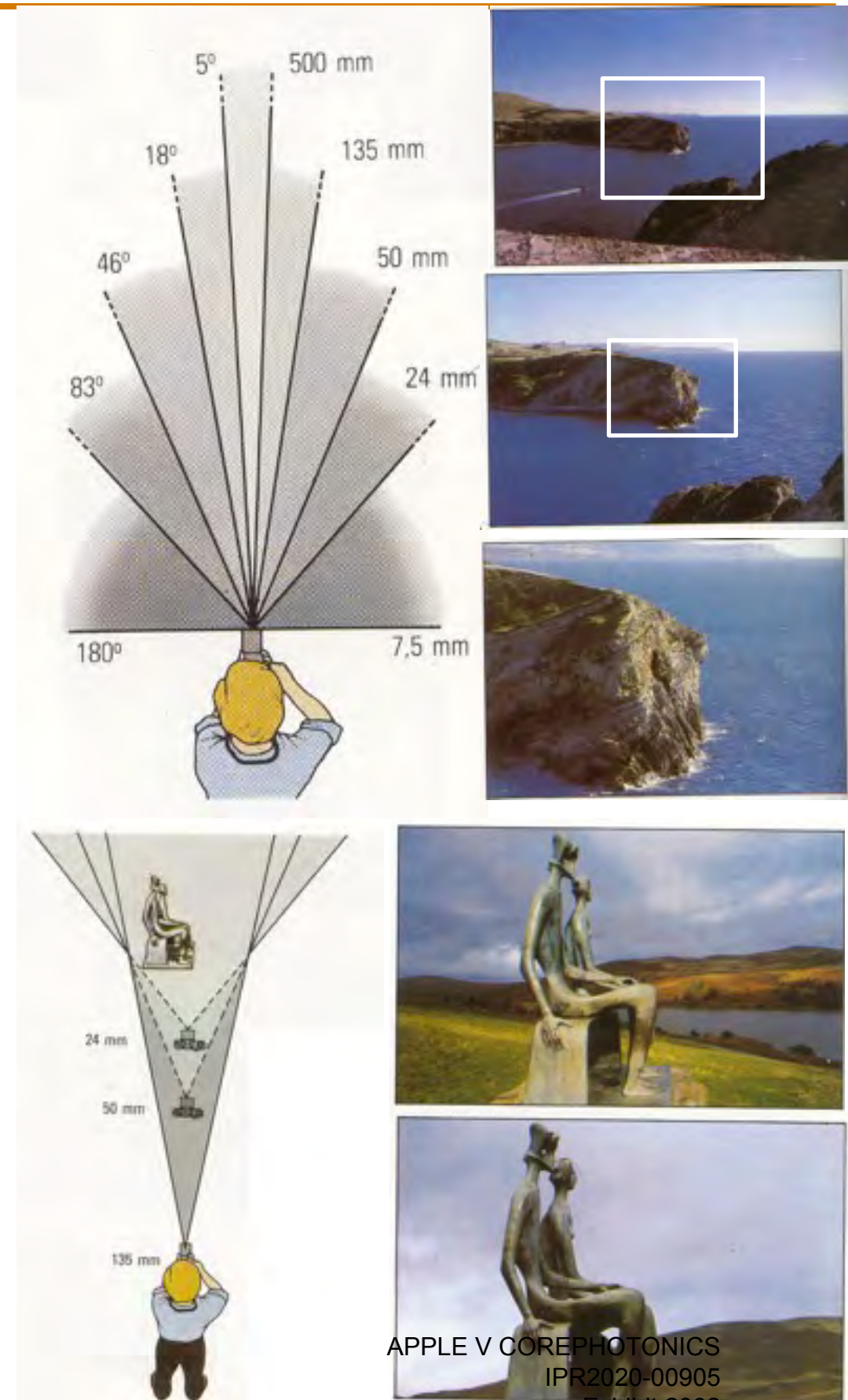
- **Different field of view for same focal length**
 - hence the “crop factor”
 - a 100mm on a low-end SLR has the same field of view as a 150mm on a high-end one
- **Larger depth of field**
- **Increased noise**



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Recap: focal length

- focal length
= field of view
= cropping
- depends on sensor size
- zooming changes the focal length
 - wide angle : $< 35\text{mm}$
 - telephoto : $> 85\text{mm}$
- difference between viewpoint and focal length



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